# PATENT SPECIFICATION

DRAWINGS ATTACHED

**901,061**

*Date of Application and filing Complete Specification Dec. 2, 1959.*
*No. 41018/59.*
*Application made in Switzerland (No. 66812) on Dec. 2, 1958.*
*Application made in Switzerland (No. 76101) on July 22, 1959.*
*Complete Specification Published July 11, 1962.*

Index at acceptance:—Class 135, P(1C:6:11:21:24K5).

International Classification:—G05b, d.

COMPLETE SPECIFICATION

## Improvements in or relating to Safety Valves

We, GESELLSCHAFT DER LUDW. VON ROLL'SCHEN EISENWERKE AKTIENGESELLSCHAFT, a Swiss Company, of Gerlafingen, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a safety valve.

In hydraulic pressure systems, for example in connection with hydrostatic gear, it is frequently necessary to have pilot-controlled safety valves operating as excess pressure valves, which enable pressure medium in the high-pressure section to flow from the latter into the low-pressure section, when the pressure in the former exceeds a predetermined value. With fluid-carrying pressure systems in which the pressure sides alternate in operation, it is thus necessary to have two valves.

A valve is already known which is operative in two directions and thus is also capable of operating with interchanging pressure sides. The known valve comprises for this purpose two pilot valves, each of which is associated with a pressure side and opens the main valve when a high pressure on that side is exceeded. Where different maximum pressures are required on the two pressure sides, it is advantageous to use such a safety valve requiring two pilot valves; on the other hand, the use thereof is not fully justified if exactly equal maximum pressures are required for both pressure sides. In addition, difficulties are involved in the setting of the two pilot valves so that they open the main valve at equal pressures.

According to the present invention, there is provided a safety valve, including a valve housing formed with first and second ports for connection to two respective sides of a fluid-carrying system of which the sides are interchangeably an exhaust side and a supply side, there being a main valve closure member mounted in said valve housing co-operating with a main valve seat to cut off communication between said ports, said member being provided with first and second pressure surfaces so arranged that, when said member is in its closed position, any fluid in said first port acts on said first pressure surface in such a manner as to urge said member to open, and any fluid in said second port acts on said second pressure surface in such a manner as to urge said member to open, there also being a chamber which is provided between said member and said housing and with which said first and second ports communicate *via* first and second non-return valves, respectively, arranged to allow fluid to flow to said chamber, said member also being provided with a third pressure surface arranged to be acted upon by any fluid in said chamber in such manner as to urge said member to close, and said chamber being in communication with a pilot valve which serves to open in response to excess pressure in said chamber, the arrangement being such that occurrence of excess pressure in either one of said ports causes, due to provision of said non-return valves, the occurrence of excess pressure in said chamber, so that said pilot valve opens whereby the force on said third pressure surface is decreased and the forces on said first and second pressure surfaces cause said member to open thus to allow communication between said ports.

In order that the invention may be clearly understood and readily carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 shows an axial section through a safety valve, and

Figure 2 shows an axial section through a modified version of the valve.

Indicated at 1 in Figure 1 is a valve housing which is formed with a cylindrical bore 2.

Arranged in this bore is a cylindrical valve sleeve 4, which is retained in the bore by a flanged cover 5 bearing on the upper side thereof. The flanged cover 5 is fixed by means of screws 6 to the valve housing 1. The valve sleeve comprises in its lower portion a peripheral groove 7, which communicates through radial bores 8 with the cylindrical space 9 formed by the sleeve. A conical portion 3 of the valve sleeve adjoining the latter below the bores or passages 8 has a minimum internal diameter *a* and forms an upwardly directed annular main valve seat 10. Displaceably arranged in the cylindrical space 9 is a cup-shaped main valve closure member 11, which is provided on its base 12 with an annular closing or sealing surface 13. This surface co-operates with the valve seat 10 when the valve member is in the closed position. Projecting into the bore 14 of the valve member 10 is a hollow guide pin 15, which is fixed in a centered position between the valve sleeve 4 and flange cover 5 by means of a flange 16 provided at the upper end of the member 15. Supported on the flange 16 is a helical compression spring 17, of which one end is pushed on the guide pin 15 and of which the other end bears on the base 12 of the valve member 11, so that the latter is held in its closed position as shown in the drawing.

The bore 18 of the guide pin 15 contains a pilot valve closure member 19, which shuts off a pilot valve inlet 21 under the action of a compression spring 20, the inlet connecting the passage 18 with a chamber or space 22 between the guide pin and valve member. Extending through the member 19 are liquid ducts 23, which communicate with an annular space 25 through radial grooves 24 provided in the flanged cover 5. The annular space 25, which is formed between the valve sleeve 4 and the wall of the bore 2 in the valve housing 1 communicates, through a discharge bore 26 in the housing, for example with a sump (not shown).

The spring 20 extends through a central threaded bore 27 in the flanged cover 5 and is supported at its upper end in an adjusting screw 28 which is screwed into the threaded bore 27. The adjusting screw is secured against turning movement in the flanged cover 5 by means of a nut 29 and is covered by a cap 30 screwed on to the flanged cover.

Provided in the base 12 of the valve member 11 are two non-return valves 31 and 32 in the form of spring-loaded balls, one of which permits liquid to enter the chamber 22 from the bores 8 through a duct 33 and the other permits liquid to enter the chamber 22 through a duct 34 from the bore in the portion 3, whilst the discharge of liquid in the reverse direction is prevented by these valves. The valve housing 1 has two connecting ports or bores 35 and 36, the first of which communicates with the annular groove 7 and the latter with the bore in the portion 3.

The operation of the safety valve as set out below is based on the assumption that the connecting bores 35 and 36 communicate respectively with the two sides of a liquid pump, for example in hydrostatic vehicle gear, the purpose of the safety valve being to permit the opening of the connection between the bores 35 and 36 when a predetermined maximum pressure is exceeded on the high pressure side so that medium under pressure can flow to the low pressure side.

Let it be assumed that the bore or passage 35 to the high pressure side is closed. In this case, medium under pressure can flow from the peripheral groove 7 and by way of the bores 8, passage 33 and opened non-return valve 31 into the chamber or space 22, so that the pressure acting on the high pressure side obtains in the space 22, since the non-return valve 32 is closed. The pressure obtaining inside the space 22 acts on a circular pressure surface with a diameter *d* on the valve member 11 and, supported by the pressure of the spring 17, urges the member 11 against the valve seat 10. The pressure of the medium in the bores 8 acting on the annular pressure surface established by the dimension $b_2$—$b_1$ is not able to lift the valve member from the valve seat 10 and produce the connection with the bore 3, because of the forces acting in the closing direction. The pressure existing in the space 22 also operates through the bore 21 on the member 19 of the pilot valve, which member is however retained in its closed position under the action of the compression spring 20. The compression spring 20 is adjusted to a predetermined biasing value by means of the adjusting screw 28, this value corresponding to the response pressure of the pilot valve or aiding in determining the response pressure.

If the pressure obtaining on the high pressure side or in the bores 8 and chamber 22 exceeds the response pressure of the pilot valve, the member 19 is displaced upwardly against the action of the spring 20, so that pressure medium can discharge from the space 22 through the bore 21 and the bores 23 into the bore 18, which communicates through the grooves 24 with the discharge passage 26. As the passage 33 is only of small cross-section and acts as a throttle, a pressure difference is set up between the bores 8 and the space 22, the smaller pressure obtaining in the space 22 and acting on the surface *d* not being capable of holding the valve member 11 in the closed position. Against the action of the spring 17, the valve member 11 is displaced upwardly by the pressure acting on the annular surface established by the dimension $b_2$—$b_1$, so that pressure medium can discharge from the bores 8 into the bore in the

portion 3, which bore communicates with the low-pressure side.

The pilot valve and main valve are closed again as soon as the pressure in the space 22 again balances the response pressure of the pilot valve and a pressure difference also no longer exists between this space and the high-pressure side.

If the bore in the portion 3 is connected to the high pressure side, the operation is in accordance with that as described above, with the exception that the space 22 is in communication through the non-return valve 32 and the restricted passage 34 with the high-pressure side. In addition, the pressure operative over the circular pressure surface *a* is decisive for the opening of the main valve and displacement of the valve member 11.

The oil discharging through the discharge passage 26 can be collected in an oil sump and used again.

As the pilot valve, because of its connection to the space 22, is operative for either one of the two pressure sides, it is assured that the set maximum pressure cannot be exceeded on the side which at that time is the high-pressure side.

Whereas the regulation of the spring bias and thus of the response pressure is effected by means of the screw 28 in the constructional example shown in Figure 1, it would instead also be possible for a piston displaceable under the pressure of a control medium to act on the spring. In such a case, it would be conceivable to arrange the piston so that it is movable between a plurality of end positions, so that predetermined fixed values can be set for the biasing the spring.

In the constructional example according to Figure 2, the reference 101 designates a valve housing, which comprises a cylindrical bore 102. Arranged in this bore is a valve sleeve 104, which is secured in the bore by a flanged cover 105 bearing on the upper side thereof. The flanged cover 105 is secured by means of screws 106 on the valve housing 101. The valve sleeve comprises in its lower portion a shoulder 107 in which are provided radial apertures 108 which communicate with the cylindrical space 109 formed by the sleeve. A conical portion 103 of the valve sleeve beneath the openings 108 has a reduced internal diameter and forms an upwardly directed annular valve seat 110. Displaceably arranged in the space 109 is a cup-shaped main valve member 111 which is provided at its base 112 with an annular sealing surface 113. This co-operates with the valve seat 110 when the valve member is situated in the closed position. A hollow guide pin 115 is secured in a centered position between the valve sleeve 104 and the flanged cover 105 by means of a flange 116 provided at its bottom end. Supported on the flange 116 is one end of a helical compression spring 117, of which the other end bears on the base 112 of the valve member 111 so that the latter is held in its closed position as shown in the figure.

The bore 118 of the guide pin 115 contains a displaceable pilot valve closure member 119 which, under the action of a compression spring 120, closes a pilot valve inlet 121 which connects the bore 118 with the chamber or space 122 between the guide pin and the valve member. Formed in the member 119 are liquid ducts 123 which communicate through radial grooves 124 provided in the flanged cover 105 with an annular space 125. The annular space 125, which is formed between the valve sleeve 104 and bore 102 in the valve housing 101, communicates by way of a discharge bore 126 in the latter, for example with a sump (not shown).

The spring 120 extends through a central threaded bore 127 in the flanged cover 105 and is supported at its upper end in an adjusting screw 128, which is screwed into the threaded bore 127. The adjusting screw is secured against turning movement in the flanged cover 105 by means of a nut 129 and is covered by a cap 130 screwed on to the flanged cover.

Provided in the base 112 of the valve member 111 are two non-return valves 131 and 132 in the form of spring-loaded balls, which valves permit passage of fluid from the openings 108 and the bore in the portion 103 to the space 122, but prevent passage of liquid in the opposite sense. Downstream of the valves 131 and 132 are a passage 133 and an adjustable throttling screw 134. The valve housing 101 has two connecting bores 135 and 136, of which the former communicates with the openings 108 and the latter with the bore in the portion 103.

At its upper end, the valve member 111 is reduced from the diameter $b_2$ to a smaller diameter *d*, the corresponding surface acted upon from the space 122 being of equal effective area to each of the two opening surfaces which are determined by the dimension $b_2$—$b_1$ and the diameter *a*. The annular space 137 defined by the dimension $b_2$—d is in communication by way of a bore 138 with a longitudinal groove 139 on the outside of the valve sleeve 104, the groove opening into the peripheral groove 125. The annular space 137 is thus constantly connected to the discharge 126.

The operation of the safety valve as hereinafter described is based on the assumption that the connecting bores 135 and 136 are in communication with the two sides of a liquid pump, for example in hydrostatic vehicle gear, the valve having the purpose of opening the connection between the bores 135 and 136 and allowing medium under pressure to flow to the low-pressure side when a prede-

termined maximum pressure is exceeded on the high-pressure side.

Let it be assumed that the bore 135 is connected to the high-pressure side. In this case, medium under pressure can enter the space 122 by way of the openings 108, the passage 133, the opened non-return valve 131 and the throttle screw 134, so that the pressure acting on the high-pressure side also obtains in the space 122, since the non-return valve 132 is closed. The pressure obtaining inside the space 122 acts on the surface of diameter *d* on the valve member 111 and, assisted by the pressure of the spring 117, urges the member 111 against the valve seat 110. The pressure of the medium which acts on the annular surface established by the dimension $b_2$—$b_1$ and which exerts a force which is equal to that of the liquid pressure acting on the surface *d* cannot lift the valve member from the valve seat 110 and produce the communication with the bore in the portion 103 on account of the spring 117 acting in the closing direction. The pressure which exists in the space 122 is also operative by way of the bore 121 on the member 119, which is however held in its closed position under the action of the compression spring 120. The compression spring 120 is set by means of the adjusting screw 128 to a predetermined biasing pressure, which corresponds to the response pressure of the pilot valve or aids in determining the response pressure.

If the pressure obtaining on the high-pressure side, *i.e.* in the bores 108 and in the space 122, exceeds the response pressure of the pilot valve, the member 119 is displaced upwardly against the action of the spring 120, so that the medium under pressure flows from the space 122 through the bore 121 and into the bore 118, which latter is in communication through the bores 123 and the grooves 124 with the discharge duct 126. Since the screw 134 acts as a throttling device, a pressure difference is built up between the bores 108 and the space 122, the smaller pressure obtaining in the space 122 and acting on the surface with the diameter *d*. That smaller pressure, together with the closing force of the spring 117, is not able to hold the valve member 111 in the closed position. Against the action of the spring 117, the valve member 111 is displaced upwardly by the pressure acting on the annular surface established by the dimension $b_2$—$b_1$, so that pressure medium can discharge from the bores 108 into the bore 103, which communicates with the low-pressure side. The pilot valve and main valve are closed again as soon as the pressure in the space 122 is again balanced with the response pressure of the pilot valve and also there is no longer any pressure difference between this space and the high-pressure side.

If the bore in the portion 103 is connected to the high-pressure side, the operation corresponds to that which has previously been described, with the exception that the high-pressure side communicates with the space 122 through the non-return valve 132. In addition, the pressure acting on the surface *a* is decisive as regards the opening of the main valve and displacement of the valve member 111.

The oil discharging through the discharge bore 126 can be collected in an oil sump and used again.

As the pilot valve, due to its connection with the space 122, is operative for either pressure side, it is assured that the maximum pressure set on the side which at any time is the high pressure side cannot be exceeded.

It is not necessary for the surfaces which are determined by the diameters *a* and *d* and the dimension $b_2$—$b_1$ to be all of absolutely equal effective area; however, the main valve member is able to react more quickly when the closing surface corresponding to the diameter *d* is not of substantially larger effective area than each of the two opening surfaces. This permits the pressure in the system connected to the ports 135 and 136 to be controlled with only slight fluctuations.

By means of the throttling screw 134, it is moreover possible to vary the pressure drop and to adapt the throughflow to the viscosity of the pressure medium.

It is also possible for an auxiliary control valve arranged externally of the valve housing to be connected to the pressure space, which auxiliary valve can be actuated manually, or electromagnetically and manually, and which enables the closing surface corresponding to the diameter *d* to be wholly or partially relieved of pressure medium in order to open the main valve at will or in accordance with a predetermined programme.

WHAT WE CLAIM IS:—

1. A safety valve, including a valve housing formed with first and second ports for connection to two respective sides of a fluid-carrying system of which the sides are interchangeably an exhaust side and a supply side, there being a main valve closure member mounted in said valve housing co-operating with a main valve seat to cut off communication between said ports, said member being provided with first and second pressure surfaces so arranged that, when said member is in its closed position, any fluid in said first port acts on said first pressure surface in such a manner as to urge said member to open, and any fluid in said second port acts on said second pressure surface in such a manner as to urge said member to open, there also being a chamber which is provided between said member and said housing and with which said first and second ports communicate *via* first and second non-return valves, respectively,

arranged to allow fluid flow to said chamber, said member also being provided with a third pressure surface arranged to be acted upon by any fluid in said chamber in such manner as to urge said member to close, and said chamber being in communication with a pilot valve which serves to open in response to excess pressure in said chamber, the arrangement being such that occurrence of excess pressure in either one of said ports causes, due to provision of said non-return valves, the occurrence of excess pressure in said chamber, so that said pilot valve opens whereby the force on said third pressure surface is decreased and the forces on said first and second pressure surfaces cause said member to open thus to allow communication between said ports.

2. A safety valve as claimed in Claim 1, wherein said non-return valves are mounted in said member.

3. A safety valve as claimed in Claim 1 or 2, wherein said member is cup-shaped and the pilot valve closure member is provided in a hollow pin which projects into said main valve closure member and which is formed with a fluid inlet and a fluid outlet and the pilot valve seat.

4. A safety valve as claimed in any preceding claim, wherein a spring urges the pilot valve closure member into its closed position, and the force in the spring is adjustable by means of a screw.

5. A safety valve as claimed in any preceding claim, wherein said first pressure surface is an annular face of a shoulder and said second pressure surface is a circular end face.

6. A safety valve as claimed in any preceding claim, wherein each of said first and second pressure surfaces is of approximately the same effective area as is said third pressure surface, there being a spring urging said main valve closure member into its closed position.

7. A safety valve as claimed in any preceding claim, wherein downstream of said non-return valves there is disposed a throttle downstream of which said chamber is located.

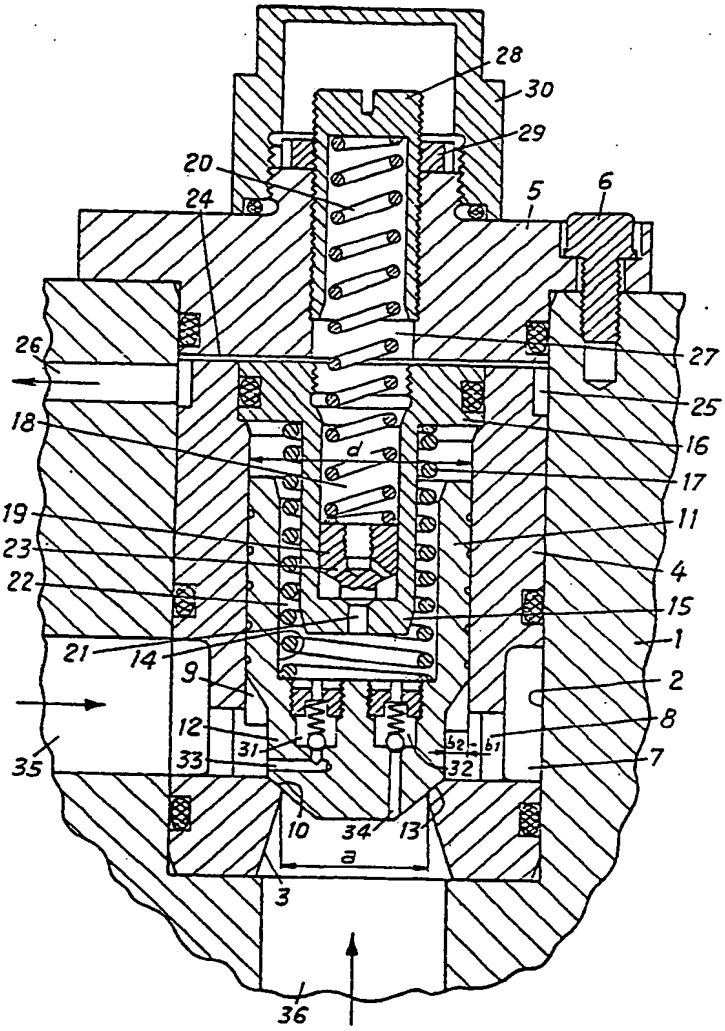
8. A safety valve as claimed in Claim 7, wherein said throttle is adjustable.

9. A safety valve, substantially as hereinbefore described with reference to Figure 1, or Figure 2, of the accompanying drawings.

HASELTINE, LAKE & CO.,
Chartered Patent Agents,
28, Southampton Buildings, Chancery Lane,
London, W.C.2,
Agents for the Applicants.

Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1962.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

Fig. 1


28
30
29
20
24
5
6
26
27
25
18
d
16
17
19
11
23
4
22
15
21
14
9
1
2
12
31
8
33
32
7
35
10
34
13
a
3
36

901061 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

Fig. 1

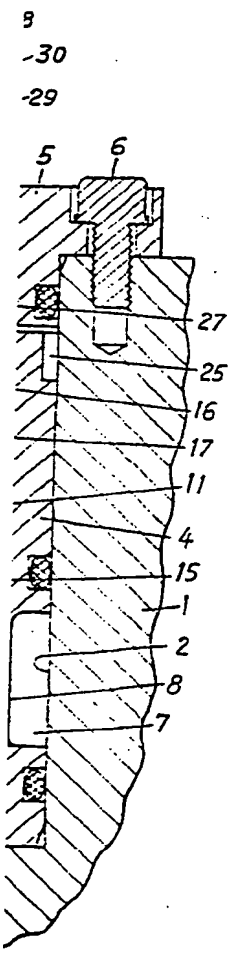
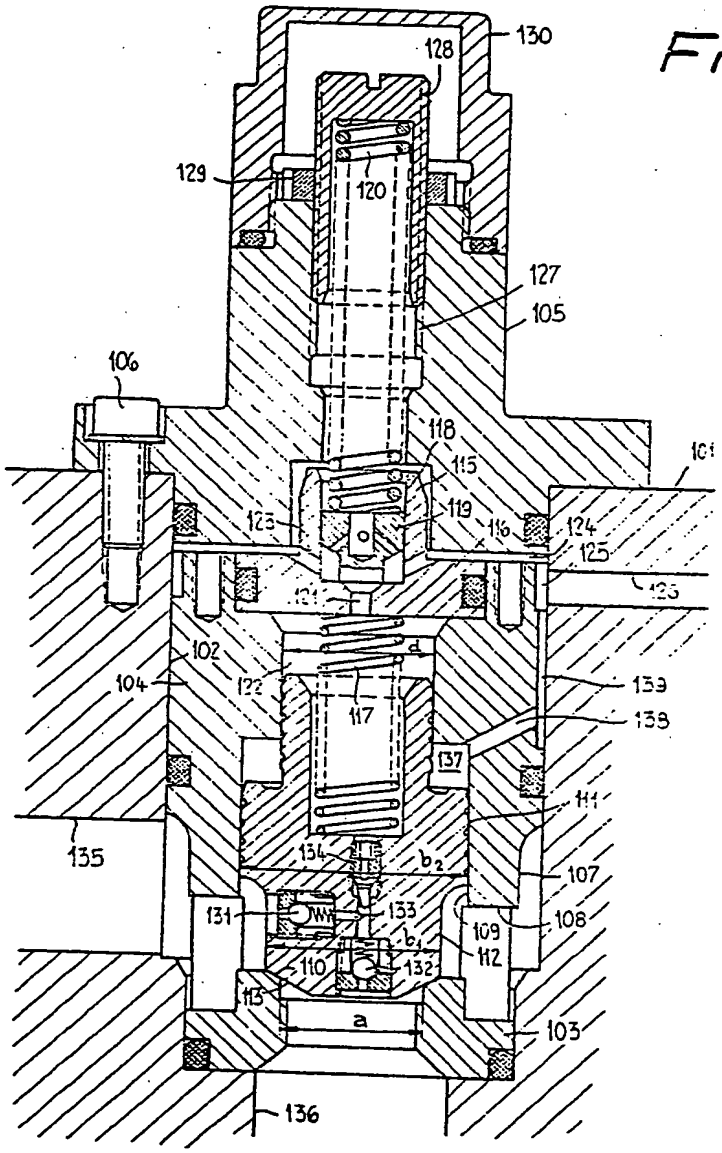



Fig. 2



901061 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

Fig.1

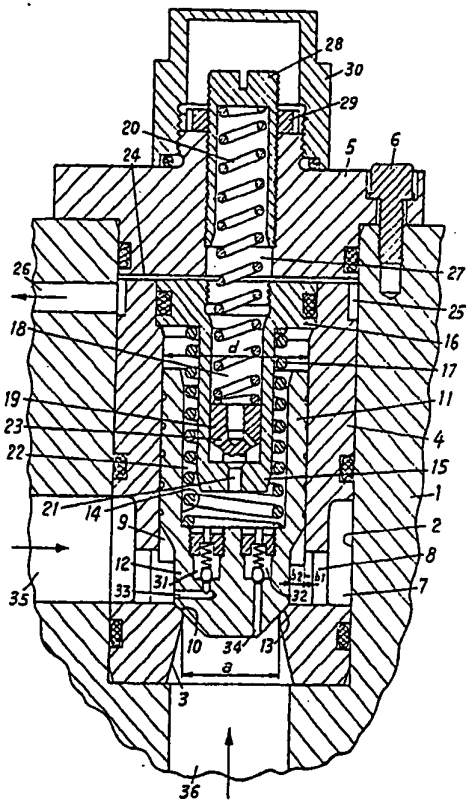



Fig.2